Integration of Topographic Engineering Skills and Tools –

Providing Assured Mobility With C2 Systems

By Mr. Ken Bergman

Officer career-level topographic engineering instruction at the Engineer School incorporates skills and tools for top-level command and control (C2). Engineer School students must understand how topographic engineering fits into the big picture regarding the supported unit's overall C2 architecture. Students who attend the Engineer School should leave Fort Leonard Wood knowing how to integrate topographic engineering solutions into the big picture in order to meet the maneuver commander's needs for assured mobility.

Topographic Engineering Skills and Tools

Maneuver commanders are effective on the battlefield only to the extent that they understand the tools and assets under their command. The ability of commanders is multiplied many times by the level of skill with which they apply the right tools to a given situation. Likewise, engineer officers are successful in providing topographic support only to the extent that they understand and apply the tools available, from the tactical level all the way back to home station operating capability (HSOC) sites in theater and in the continental United States (CONUS). Engineer C2 supports terrain understanding, improvised explosive device (IED) defeat, humanitarian relief, stability operations, support operations, and other functions that are critical components for achieving assured mobility. Following is an overview of C2 integration topics that are laid out in a question-and-answer format.

What types of terrain data do I need to know about?

Skills and tools associated with topographic engineering begin with an understanding of terrain data and its uses. Terrain data consists of scanned digital map displays, elevation data, imagery, and feature data.

Scanned digital map displays consist of Compressed Arc Digitized Raster Graphics (CADRG) files, which are used extensively in C2 systems. CADRG consists of paper maps of all scales that have been scanned and are suitable for digital map backgrounds. CADRGs at 1:50,000 and 1:100,000 scale are the most widely used for tactical operations. City maps at a 1:12,500 scale or better are also available but will not show all buildings. (This can be achieved using georeferenced imagery.) Like imagery, CADRG digital maps do not show any more detail when you "zoom in" to a higher resolution; this just makes the existing features appear larger.

Elevation data has varying levels of detail: Digital Terrain Elevation Data (DTED®) Level 1 (roughly 90-meter post spacing, bare earth); DTED Level 2 (30-meter post spacing, bare earth); Shuttle Radar Topography Mission (SRTM) 2 (30-meter post spacing, reflective surface or "treetop" data); and high-resolution terrain elevation (HRTe) data (HRTe 3, 4, and 5, at 10-meter, 3-meter, and 1-meter post spacing, respectively, reflective surface). DTED Level 1 has approximately the same level of detail that the contour lines of a 1:250,000-scale map joint operational graphic (JOG) would have. Maps at a 1:50,000 scale can be used successfully with DTED Level 2 and SRTM elevation data for line-of-sight analyses and weapons fans, but the use of DTED Level 1 with 1:50,000-scale CADRGs should be discouraged due to inaccuracies in lower-resolution elevation data.

Georeferenced *imagery* typically consists of Controlled Image Base (CIB) 5 (5-meter resolution), CIB 1 (1-meter resolution), and commercial satellite imagery. CIB imagery is useful for image map backgrounds and to display features that are not represented on digital map backgrounds. However, the image map is not a replacement for standard topographic line maps (TLM). CIB 1 is particularly useful in urban areas, but it may not provide the desired resolution for detailed urban analysis.

Vector data, also called *feature data*, provides digital representations of man-made or natural objects as points, lines, or polygons (such as wells, roads, and forests). Each feature can include embedded information, called "attribution," such as bank heights for bodies of water, type of road surface, road

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width, and bridge load-bearing class. Attribution has been called "right-click" data because information like road width and road materials is embedded in the feature. On the screen, these features look like map data, but when you right click on them with a mouse pointer, attributes about that feature are displayed. Not all feature data is fully populated, but it is still useful for display purposes. Fully attributed feature data can be used to perform automated terrain analysis or terrain reasoning.

What topographic assets do I supervise as an engineer officer?

The Digital Topographic Support System (DTSS) brings world-class geospatial support functionality to the tactical warfighter. Army terrain teams with DTSS are in high demand in current operations, and the number of terrain analysts in the field is increasing. The DTSS is being fielded to all Army terrain teams in the Stryker Brigade Combat Teams (SBCTs), unit of action (UA) brigade combat teams (BCTs), units of employment-tactical (UEx), and units of employment-operational (UEy). There are also other geospatially enabled tools available to engineers, to include the Tactical Minefield Database (TMFDB), Mobile Command System–Engineer (MCS-E), High-Volume Map Production (HVMP) System, Theater Geospatial Database (TGD), and emerging handheld personal digital assistants (PDAs) that use embedded geospatial software. The configuration of different units may vary depending on the echelon and legacy of the individual unit. The software used in each of these products is compatible with DTSS. For more information on these tools, see the Project Director (PD), Combat Terrain Information Systems (CTIS), Web site at <*http://www.tec.army.mil/systems/programs/ctis2/about/main.html*>.

Regarding the use of these tools, it is essential that engineer officers understand the following:

- Engineer officers are the "masters of terrain," both digitally (such as terrain analysis) and physically (such as emplacing obstacles and clearing maneuver routes).
- Engineers at SBCTs and maneuver BCTs (UAs) need to ensure that terrain teams and the DTSS are fully operational.
- The S2/G2 is an important customer of the terrain teams. At the UEy, a portion of the DTSS is colocated with the intelligence section.
- Engineer officers must also ensure that other users (such as the operations, fire support, and aviation sections) receive needed terrain-related products and that terrain teams have what they need to be successful in achieving their mission.

What topographic "reachback" support can I get?

The Army has significant reachback infrastructure to support terrain teams and engineer officers in the field. Tactical-level terrain teams are deployed down to the brigade level (UA). Reachback consists of terrain teams at division and corps levels (UEx and UEy); the regional HSOC, to include topographic engineering battalions and the TGD; and the US Army Corps of Engineers® Engineer Research and Development Center (ERDC) Topographic Engineering Center (TEC). Large-bandwidth communications architectures are being developed—such as the Global Broadcast Service (GBS)—to disseminate very large files into theater.

A variety of tools available to engineer officers can convey terrain understanding to the user. One of these is the Urban Tactical Planner™ (UTP), which is available through TEC. The UTP is a stand-alone software tool that is free, easy to use, and runs on any personal computer (PC). Most of the major urban areas in current operations areas are covered by a specific UTP three dimensional (3-D) fly-through loaded on a compact disk (CD), using a TerraExplorer® software package. The UTP fly-through is created using imagery and feature data draped over elevation data. Feature attribution is accessible by placing the cursor over a road feature. Key buildings in the imagery are annotated, and some are "stood up" in 3-D. DTSS operators can use UTP source data as a foundation for their urban analysis products. They can add more feature data and update existing UTP databases based on ground truth in the field.

In addition to UTP, there are other countrywide Terra-Explorer files that cover entire countries or regions, but they are typically disseminated on a FireWire (an external hard drive that contains large files, via a Universal Serial Bus [USB]-2 connection). Countrywide fly-throughs and UTPs are built and disseminated by TEC and can be edited and enhanced by terrain teams in theater using DTSS. These products are available to soldiers by contacting TEC. For more information on these and other products, go to the TEC Web site at <*http://www.tec.army.mil*>.

The National Geospatial-Intelligence Agency (NGA) provides the ultimate reachback asset in CONUS, as well as in theater, with on-site geospatial analysts who augment the terrain teams. NGA analysts should be integrated with the terrain teams to provide excellent synergy. NGA teams supplement Army terrain team capabilities but do not replace them. Coalition partners can also be crucial to the success of an operation in theater. When Army units first arrived in Afghanistan, it was the Australian topographic engineers who provided the most useful maps. Australian, British, and Canadian topographic engineers use the same software configuration as DTSS, making them readily compatible with US Army terrain teams. US Marine Corps terrain teams also use software that is compatible with DTSS.

What engineer solutions/products are needed in different C2 systems?

Part of the answer to this question can be found in Training Circular (TC) 5-230, *Army Geospatial Guide for Commanders and Planners*. It contains explanations and examples of some of the common types of overlays and products that DTSS

produces for digital or hard-copy use by customers in different functional areas. In addition, the terrain teams in theater are using customized products that support IED defeat.

Integrating Topographic Solutions in Today's C2 Environment

To understand where we are in today's C2 architecture, we need to examine the recent past in fielding various C2 systems. The Army's C2 environment has a variety of components, some of them developed through the traditional acquisition cycle and some through ad hoc associations with the joint community. The Army Battle Command System (ABCS) incorporates different functional area C2 tools, to include the following:

- Mobile Control System (MCS) for operations.
- All-Source Analysis System (ASAS) for intelligence.
- DTSS for topographic engineering support.
- Advanced Field Artillery Tactical Data System (AFATDS) for fire support.
- Air and Missile Defense Workstation (AMDWS) for air defense.
- Battle Command Sustainment Support System (BCS3) for logistics.
- Tactical Airspace Integration System (TAIS) for aviation.
- Force XXI Battle Command–Brigade and Below (FBCB2) for tactical- and platform-level operations.
- Global Command and Control System–Army (GCCS-A) for joint connectivity.
- Integrated Meteorological System (IMETS) for weather.

The ABCS was fielded to the digital divisions and the SBCTs prior to Operation Iraqi Freedom. Various parts of the ABCS were available to other units. One ABCS capability that was rushed into the field for Operation Iraqi Freedom was the FBCB2 and its commercial satellite surrogate known as Blue Force Tracking. The digitized divisions were equipped with DTSS down to the brigade level, while the nondigitized divisions had only division-level terrain teams. It is clear that ABCS provides extensive C2 capabilities for the major functional areas in the Army. However, prior to Operation Iraqi Freedom, not all units had ABCS; there were digital and nondigital units, which left some users without a standard C2 architecture.

Given the varied C2 configurations, V Corps did not have adequate C2 support because of the ABCS shortfall. While Operation Iraqi Freedom was in its planning stages, commanders decided that the nondigitized units needed some C2 tools quickly. They chose to use Command and Control Personal Computer (C2PC) because it is free, reliable, easy to use, and runs on any PC. C2PC was employed in the initial stages of Operation Iraqi Freedom and is still being used at the corps and joint levels in Iraq and elsewhere.

The Army is preparing to release Software Block 1, based on ABCS, which will be fielded to the entire Active Army and Reserve Component. There will be accelerated fielding of these new digital systems to nondigital units over the next two to three years. This will provide the Army with needed C2 standardization.

FalconView™ is a terrain visualization tool that is used extensively in Operation Iraqi Freedom and throughout the Army. Like C2PC, it is free, reliable, easy to use, and runs on any PC. Planning teams use FalconView to view digital maps and imagery and to build control measure overlays for export to other C2 systems. It can also serve as a data interchange tool between ABCS and C2PC.

Engineers need to build an understanding of these tools and their role in C2. DTSS can provide digital products to all of the ABCS C2 tools and C2PC. Commanders and battle staffs will require varying types of geospatial products, depending on their individual experience base and unique requirements. It is essential that engineers understand how to help commanders achieve assured mobility by providing responsive products to the battle staffs and their respective C2 systems.

How do I export digital engineer solutions into different C2 systems?

Exporting topographic products to C2PC can be achieved by terrain teams using export tools directly from DTSS or by sending files from DTSS to FalconView and then transforming files into C2PC format. DTSS can reformat products for export to almost any other system. Only the Joint Technical Architecture-compliant systems that use the Commercial Joint Mapping Toolkit (CJMTK) can use all NGA and DTSS products in their native formats. There is a wide range of proprietary and nonstandard map viewers used by non-ABCS and many ABCS systems. This is a continual challenge to DTSS operators. Fortunately, MCS and ASAS in ABCS 6.4 Army Software Block 1 will use CJMTK in the future, ensuring seamless interoperability of geospatial information within the ABCS.

What about dissemination?

There are many graphics that depict dissemination of data, with "lightning bolts" going from one system to another. At higher levels of command, large files can be transmitted into theater using GBS and other large-bandwidth capabilities. However, for the last tactical mile, soldiers typically use high-frequency radios. Digital overlays that are disseminated via radio should contain as much information as possible with a very small file size. CDs, digital video disks (DVDs), and FireWires are often used to disseminate large files. In digitized units, hard drives loaded on mounted vehicles contain a small standard basic load of geospatial data. At the Central Technical Support Facility (CTSF), Fort Hood, Texas, the system master hard drive is loaded with operational software and required terrain data. The master is then replicated to many hard drives

for use in ABCS and FBCB2 on vehicles. The CTSF does this on an ongoing basis, and technical support teams in the field provide the same functionality.

Unit basic geospatial loads of digital maps, imagery, elevation data, feature data, and special terrain products are stored on the Army Map Server in each DTSS-Light. These map servers provide digital terrain products from NGA, commercial sources, DTSS, Army theater-level topographic engineering assets, and TEC. Products from the map server can be exported to ABCS via the tactical operations center (TOC) local area network (LAN). This data should not be pulled from one TOC to another over tactical communications links because of bandwidth limitations. The Army Map Server allows for storage of more than a terabyte of high-resolution data to be used as needed by battle staffs. It also enables terrain analysts to be geospatial managers on the battlefield and to ensure that all systems have access to the most current geospatial data and products. The Army Map Server is accessed via the Web interface in the TOC LAN, and system operators can graphically select or use geolocations to download terrain data and products into their system.

Summary

At the Engineer School, students are provided an excellent overview of topographic engineering, as well as top-level integrating skills they will need to bring it all together in the field. Some students will be assigned to units that will expose them to the "big picture" early on. They will benefit from this experience and will develop innovative ways to integrate engineer solutions for their customers. Others may not see how all of the pieces fit together, depending on their initial assignments, so it is important that they acquire an understanding of C2 integration concepts in career-level training classes. They should know which products from DTSS are used for different tactical situations and missions (TC 5-230), how to employ and lead terrain teams, what the different C2 tools are used for, and how to bring the right tools and skills to the situation at hand. Armed with this basic knowledge, students will more rapidly acquire additional digital topographic C2 skills and tools as they are deployed to different assignments throughout the Army. These skills and tools are key enablers for engineers as the masters of terrain to achieve assured mobility.

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